

ARMY PARTNERSHIPS IN MOTION

# Fuel Cell Development for Army Ground Vehicles

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NATIONAL AUTOMOTIVE CENTER

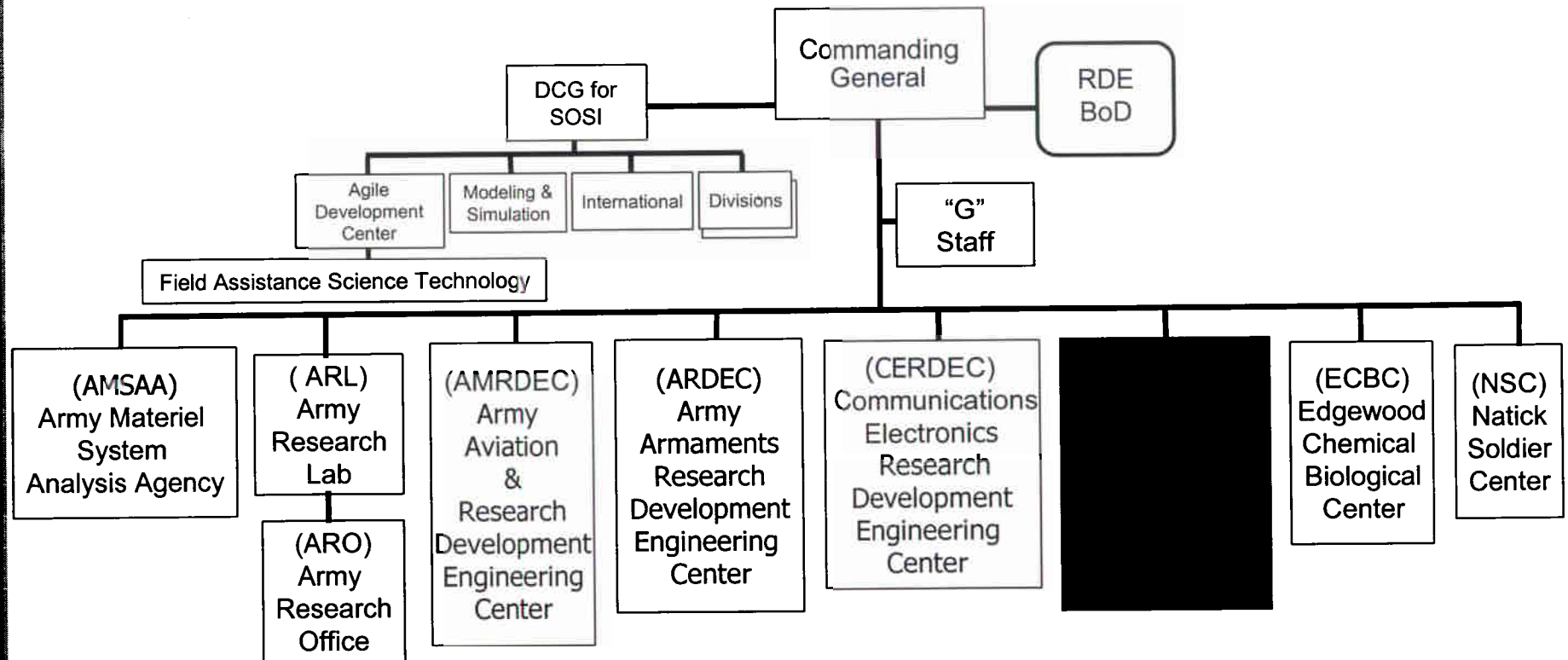
Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE <b>16 MAY 2006</b>		2. REPORT TYPE <b>N/A</b>		3. DATES COVERED <b>-</b>	
4. TITLE AND SUBTITLE <b>Fuel Cell Development for Army Ground Vehicles</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) <b>Dobbs, Herb</b>				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>USA TACOM 6501 11 MILE ROAD WARREN, MI 48397-5000</b>				8. PERFORMING ORGANIZATION REPORT NUMBER <b>15844</b>	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S) <b>TACOM TARDEC</b>	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) <b>15844</b>	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release, distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>SAR</b>	18. NUMBER OF PAGES <b>13</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

# Outline

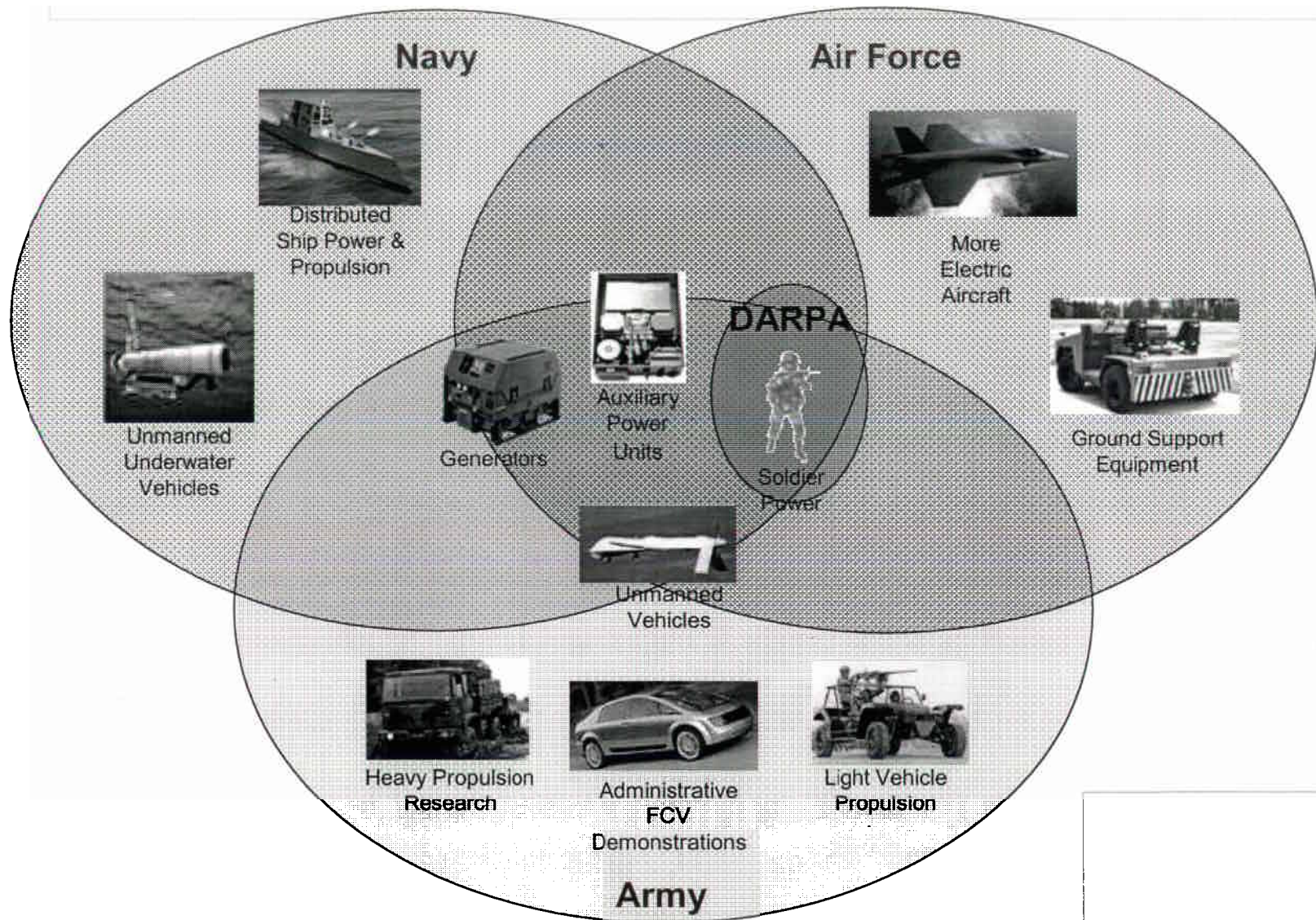
- Where TARDEC fits
- APU history at TARDEC
- Ongoing efforts
  - Reformer
  - Desulfurization
  - Modeling and simulation
- Upcoming programs



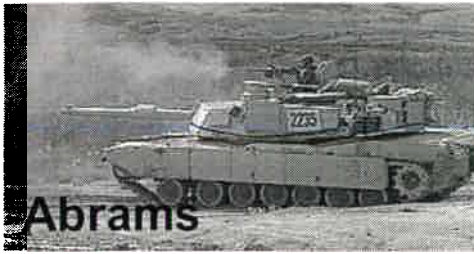
# Research, Development and Engineering Command



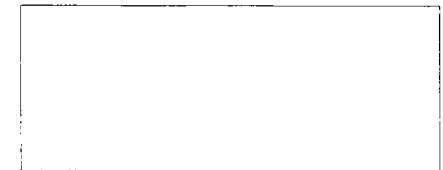
# DoD Fuel Cell Focus Areas



# Why Fuel Cell Auxiliary Power?



- Electric power requirements increasing as vehicles are modernized
- Silent watch requirements
  - Thermal signature
- Crew comfort
- Packaging constraints
- Logistic fuel compatibility
- Dual-use applications for long term affordability



## Ongoing Efforts Later in Conference

- Precision Combustion
- University of Michigan
- PNNL
- Auburn University
- T/J Technologies



# Fuel Cell APU Progress

**1998**



Fuel cell integration  
in a conventionally  
driven heavy duty  
truck

**2002**



SOFC APU and  
reformer  
development



PEM APU and  
methanol and  
synthetic diesel  
reformer  
development



Regenerative  
PEM APU  
proof of  
concept

**2004**



SOFC reformer  
development



Microchannel  
distillation and HDS  
development

Microlith JP-8  
gasifier and pre-  
reformer



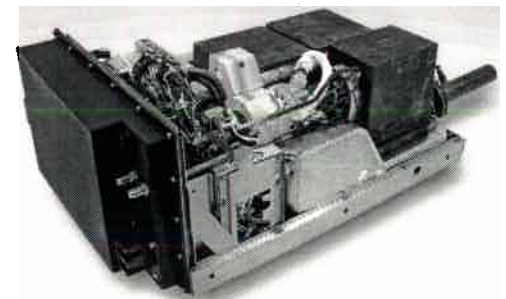
Prototype  
integration of an  
microtech and PEM  
based low S APU



Regenerative PEM  
APU functional  
integration

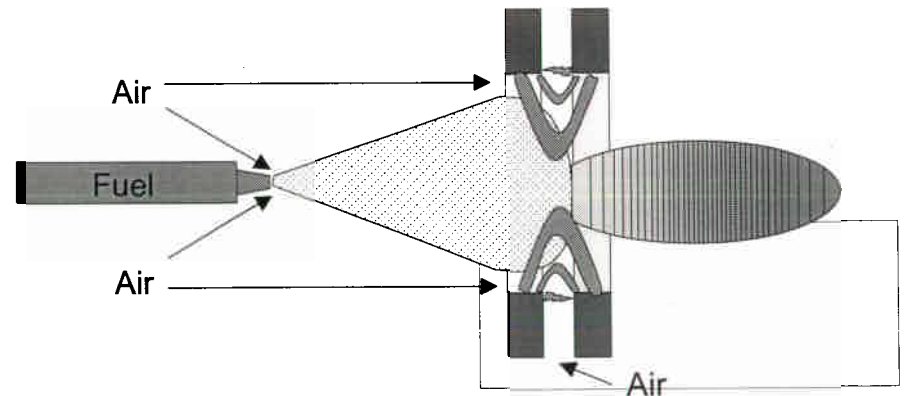
## Reformer for Solid Oxide Fuel Cell Application

- Reformer development being performed by Delphi, significant leverage of fuel cell development and prior system design done under SECA
- New APU design, yielding a family of products that meet the needs of current ground combat vehicles
- Delphi will work with a model JP-8 fuel stream.
  - The project included the design of a low sulfur test fuel that can be commercially procured
- Reformer demonstration ready to be conducted



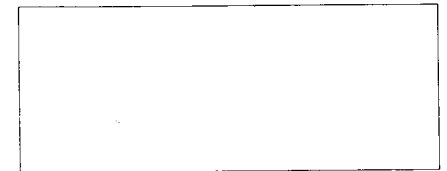
# Dual Use Plasma Reformation

- FY06 Congressional to be executed by ArvinMeritor
- Builds on cooperative work with MIT and self funded internal developments
  - Prior work yielded several plasmatron design iterations and application verification using reformatate surrogates to include hydrogen enhanced combustion
- TARDEC project will have a dual focus on diesel engine after treatment applications and reformation for fuel cell applications
- Very close to start of work

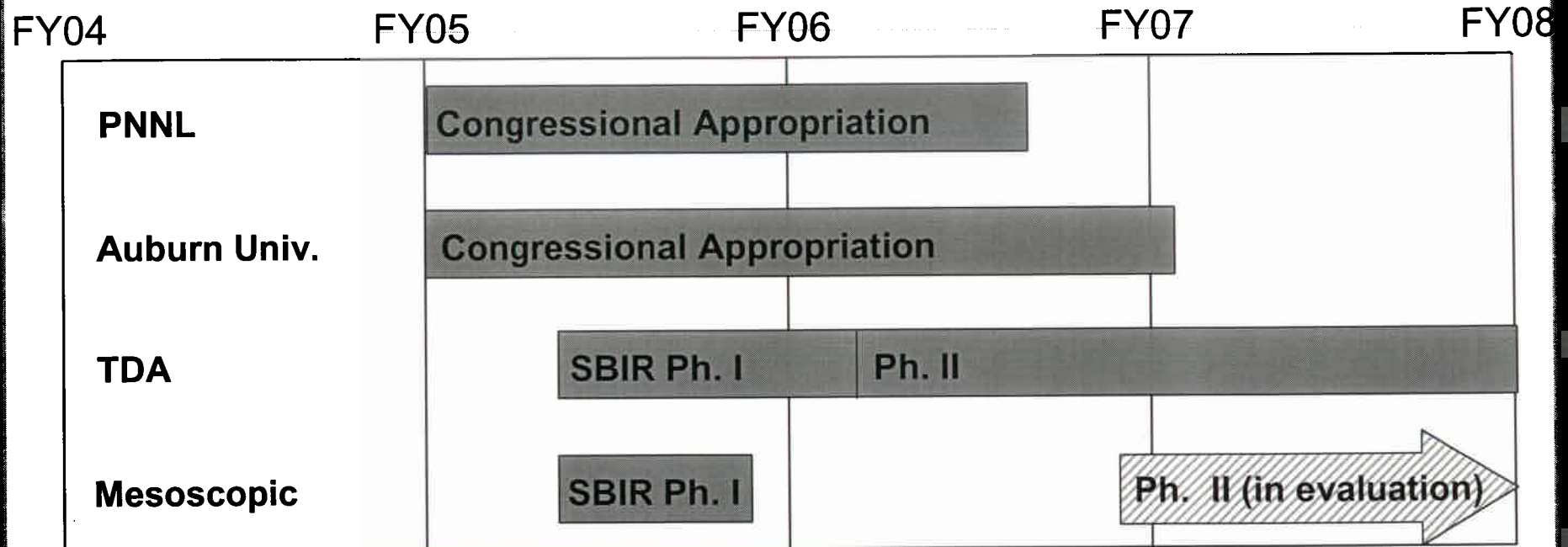


# Liquid JP-8 Desulfurization System Development

- Currently utilizing Small Business Innovative Research awards and congressional defense appropriations to investigate novel methods for removing sulfur from logistic fuel
- Partnering with the Department of Energy (PNNL) and the Office of Naval Research to leverage efforts
- Efforts with TDA Research, PNNL, Auburn University, and Mesoscopic Devices
- Efforts include optimizing adsorbents for sulfur removal from JP-8, developing innovative regenerating system designs and reactors, and breakthrough catalyst supports



# Program Schedule Timeline



**PNNL:** Microchannel distillation and reformat driven hydrodesulfurization system bench-top demonstrator

**AU:** Innovative catalyst supports based off paper manufacturing technology

**TDA:** Regenerable, high breakthrough-capacity sulfur adsorbent

**Mesoscopic:** Continuously regenerating multi-bed desulfurizer demonstration system sized for 5 kW FC APU

# Modeling and Simulation

- To date this has not been a major area of focus for TARDEC
- University of Michigan, Jing Sun - Naval Architecture
  - Logistics fuel reformer and fuel cell modeling
  - Investigates the control problem of operating a JP-8 reformer coupled to a fuel cell stack
  - Builds upon prior efforts under the Navy's Ship's Service Fuel Cell program
- University of Michigan, Anna Stefanopoulou – Mechanical Engineering
  - Numerous projects under the Automotive Research Center
  - Investigations into a variety of system and subsystem control issues; water management and air supply

## **Fuel Reformation Army Technology Objective**

- Multi-year effort to develop reformer systems to meet the Army's ground vehicle auxiliary power needs
- Two phased approach was solicited under a Broad Agency Announcement
  - Reformer development and validation
  - Fuel cell integration
- Two awards for two year phase I programs

